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Are native plant gardens better for conserving bird populations than gardens with exotic plants?

Jessica Ann Gouveia

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ABSTRACT

Loss of species habitat due to rapid deforestation of the earth's forests is a pertinent and serious problem. This issue especially affects birds. One way in which scientists and conservationists have suggested people could help conserve bird populations is by gardening. Many horticulturalists want to bring in ornamental exotic species of plants, however, it is believed by some that they offer little contribution to a functional ecological system; they do not harbor as many insects, nor do they have an ecological history with the birds of the native habitat. In this study, I examine the issue of whether native plants offer better habitats for bird conservation by comparing the birds that visit the native garden at the Biological Station of Monteverde (EBMV), an exotic garden at Los Pinos, and a mixed species garden at El Bosque. After comparing the different birds that visited each of these gardens and dividing them into categories based on their preferred habitat, I did not find a difference in the number of species that visited each garden, but I did find a difference in the type of species that I found. Overall, I found that the native plants support bird populations with more specialized habitats better than exotic plants do.

At one point, the entire region of Monteverde was covered by primary forest. All of its savannas and grasslands have been created by human activity (Nadkarni & Wheelwright 2000). For example, the dry, open area along the road to Monteverde, from the Inter-American Highway, is kept up by burning, clearing, and cattle grazing. As deforestation persists throughout Central America, and in Monteverde, a lot of bird species are threatened because of loss of habitat and food sources (Nadkarni & Wheelwright 2000).

Scientists and conservationists are constantly thinking of ways to offset the damages of deforestation (Foley *et al.* 2005). One idea that has been suggested to help conserve bird populations is to make the best of already disturbed areas by turning them into native plant-dominated gardens, and by turning current gardens into native plant-dominated areas (Tallamy 2009). Douglas Tallamy, 2009, suggests that although some species need primary forest and could never live in disturbed areas, many birds would benefit from a well-designed garden of native plants. Along the lines of this idea, gardeners would aim to imitate the habitat that has been cut down by using native species to replicate what has gone missing in food and shelter. The idea is that this would better support bird communities than a patch of grass or any human-constructed structure would (Tallamy 2009).

However, there is conflict in the world of gardening between the proposal of using native species to support birds and the idea of planting for aesthetic pleasure. A large community of horticulturalists want to bring new, alien plants into the natural environment (Reichard & White 2001). Although some exotic plants serve a medicinal purpose, a lot of exotic species have been imported and planted for purely ornamental purposes (Reichard & White 2001). However, it is thought that exotic species offer little to a functioning ecological system. For example, they do not harbor a large or diverse

population of insects; insects will not eat them (Tallamy 2009). This is because most horticulturalists choose pest-free plants so that their garden will stay intact and pretty. Also, insects have to develop and adapt to the chemical defenses of plants (Reichard & White 2001). So, if a new species of plant is introduced with a new poison in its leaves, the insect will not be well adapted to feed on it; it needs an evolutionary history with the plant (Tallamy 2009).

It makes sense to plant native plant species if one's goal is to conserve bird populations; planting native species is a way to mimic what is lost by deforestation by bird populations, and exotic plants offer little support for a major food source for birds (insects). The aim of this project was to determine if an area of native plants actually makes for a better habitat for birds than an area full of exotic species. I compared bird species composition at a native, an exotic, and a mixed species plant garden to determine which is better for bird conservation and why.

MATERIALS AND METHODS

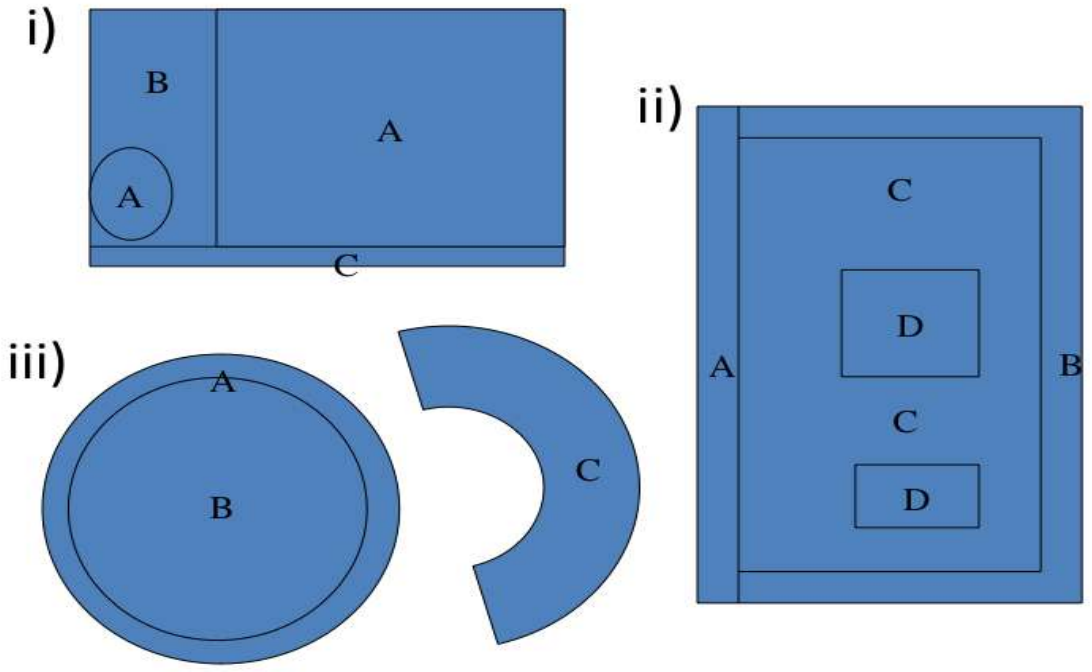

Figure 1. Shows maps of each of the gardens I observed in Monteverde, July, 2008. Part i.) was EBMV and EBMV2, part ii.) was Los Pinos, and part iii) was El Bosque. The A's, B's, and C's represent certain sections of the gardens with different vegetation cover.

Study sites—This research was conducted in three gardens around Monteverde, Costa Rica, in the premontane wet forest life zone. The three gardens were the Biological Station of Mondeverde (EBMV1 & EBMV2), Los Pinos, and El Bosque, a native plant-dominated garden, an exotic plant-dominated garden, and a mixed species plant garden, respectively. Note that the Biological Station of Monteverde served as both EBMV and

EBMV2. It was the same garden. The two different notations represented the two different weeks that it was sampled.

Table 1. *Shows the type of plant species that were present in certain sections of the gardens I observed in Monteverde, July, 2010, and whether they were native or exotic.*

Garden	Section	Plant	Plant type
EBMV/EBMV2	A	*Ageratum petiolatum*	Native
EBMV/EBMV2	A	*Agratum sp.*	Native
EBMV/EBMV2	A	*Arthrostemma ciliatum*	Native
EBMV/EBMV2	A	*Asclepias curassavuca*	Native
EBMV/EBMV2	A	*Calathea crotalifera*	Native
EBMV/EBMV2	A	*Canna tuerckheimii*	Native
EBMV/EBMV2	A	*Cavendishia capitulata*	Native
EBMV/EBMV2	A	*Conostegia xalapensis*	Native
EBMV/EBMV2	A	*Costus s.*	Native
EBMV/EBMV2	A	*Epidendrum radicans*	Native
EBMV/EBMV2	A	*Gunnera insignis*	Native
EBMV/EBMV2	A	*Habracanthus biepharorachis*	Native
EBMV/EBMV2	A	*Hamelia patens*	Native
EBMV/EBMV2	A	*Lantana camara*	Native
EBMV/EBMV2	A	*Lantana sp.*	Native
EBMV/EBMV2	A	*Mucuna monteverde*	Native
EBMV/EBMV2	A	*Peporomia sp.*	Native
EBMV/EBMV2	A	*Phytolacca rivinoides*	Native
EBMV/EBMV2	A	*Piper friedrichsthalii*	Native
EBMV/EBMV2	A	*Poikilacanthus macranthus*	Native
EBMV/EBMV2	A	*Pseuderanthemum cuspidatum*	Native
EBMV/EBMV2	A	*Psychotria uliginosa*	Native
EBMV/EBMV2	A	*Smallanthus maculatus*	Native
EBMV/EBMV2	A	*Solanum americanum*	Native
EBMV/EBMV2	A	*Stachytarpheta frantzii*	Native
EBMV/EBMV2	A	*Tradescantia canonia*	Native
EBMV/EBMV2	A	*Vovvania frutescens*	Native
EBMV/EBMV2	A	*Vriesea sp.*	Native
EBMV/EBMV2	A	*Vrowallia Americana*	Native
EBMV/EBMV2	A	*Xanthosoma undipes*	Native
Los Pinos	C	*Alpinea zerumbet*	Exotic
Los Pinos	C	*Antherium andreanum*	Exotic
Los Pinos	C	*Begonia sp.*	Exotic
Los Pinos	C	*Brunfelsia pauciflora*	Exotic
Los Pinos	C	*Cordyline terminalis*	Exotic
Los Pinos	C	*Cycus revoluta*	Exotic
Los Pinos	C	*Dichorisandra thyrsiflora*	Exotic
Los Pinos	C	*Ensetes sp.*	Exotic
Los Pinos	C	*Eriobatyra japonica*	Exotic
Los Pinos	C	*Impatiens sp.*	Exotic
Los Pinos	C	*Pachystachys Lutea*	Exotic
Los Pinos	C	*Peperomia argyreia*	Exotic
Los Pinos	C	*Prunus persica*	Exotic
Los Pinos	C	*Strelitzia reginae*	Exotic
Los Pinos	C	*Tagetes so.*	Exotic
Los Pinos	C	*Zantedeschia sp.*	Exotic
Los Pinos	C	*Acnistus arborescens*	Native
Los Pinos	C	*Calathea crotalifera*	Native
Los Pinos	C	*Cestrum lanatum*	Native
Los Pinos	C	*Eugenia montevidensis*	Native
Los Pinos	C	*Ficus sp.*	Native
Los Pinos	C	*Heliconia wagneriana*	Native
Los Pinos	C	*Inga tonduzii*	Native
Los Pinos	C	*Lantana camera*	Native
Los Pinos	C	*Myrsine coriacea*	Native
Los Pinos	C	*Odontonema tubaeforme*	Native
Los Pinos	C	*Okotoe montevidensis*	Native
Los Pinos	C	*Renealmia cernua*	Native
Los Pinos	C	*Solanum umbettlatum*	Native
Los Pinos	C	*Spathiphylum sp.*	Native
El Bosque	C	*Camadorea costaricana*	Native
El Bosque	C	*Colostygia xalapensis*	Native
El Bosque	C	*Cordyline terminalis*	Native
El Bosque	C	*Montana guatemalensis*	Native
El Bosque	C	*Pursea americana*	Native
El Bosque	C	*Rivina humilis*	Native
El Bosque	C	*Stachytarpheta frantzii*	Native
El Bosque	C	*Hybiscus rosasinensis*	Exotic
El Bosque	C	*Hydrangeas sp.*	Exotic
El Bosque	C	*Malvabiscus pendulaflora*	Exotic
El Bosque	C	*Monrada didyma*	Exotic

The garden at the Biological Station was approximately 1,084 m^2. About 5% of area A of Figure 1 consisted of cement for pathways. 25% of the area was constituted by trees including a few native trees: *Quercus insignis*, of the Fagaceae family, *Psidium guajava*, of the family Myrtaceae, and *Conostegia Xalapensus,* of the family

Melastomataceae. There was also a nonnative tree, *Eriobotrya japonica*, of the family Rosaceae, which made up 20% of the trees. This area also included many native plants (for full description of these plants, see Table 1). Part B of the figure consisted of grass, and part C was dominated by the exotic species *Hibiscus rosasinensis,* of the Malvaceae family.

The garden at Los Pinos was approximately 2,413 m^2. Referring to part ii of Figure 1, part A made up approximately 10% of the garden. It was dominated by the exotic tree species *Dypsis lutescens,* of the family Arecacea. Part B made up approximately 20% of the garden. It was dominated by the exotic species *Cupressus Lusitanica*, of the Cupressaceae family. Other trees mixed in this part included the native species *Citharexylum costaricensis,* of the family Verbenaceae family, and *Persea Americana* of the Lauraceae family. Part C consisted of some scattered trees, plants, and shrubbery amongst grass (for full description of composition, see Table 1). Part D was made up of cabins. It made up about 17% of the garden. This part also had a few cement pathways, which made up about 5% of the garden. Surrounding the garden were more gardens, cabins, and a driveway.

El Bosque was approximately 2,104 m^2. Referring to Figure 3, the part labeled A took up $1/4^{th}$ of the part A and part B combined. It was completely constituted by trees, about 85% of which were native. These native trees included the species: *Tapirira mexicana*, of the Anacardiaceae family (which was the most common), *Viburnum costaricanum, Ehretia latifolia*, *Cinnamomum sp*., *Roupala sp*., *Quercus brenesii*, *Ficus benjamina*, *Myccia splendens*, *Eugenia montevidensis*, and a tree in the *Myrtacaea* family. The non-native trees included the species: *Arial batria*, *Jacaranda mimosifolia*, and *Syzygium jambos*. The part labeled B in Figure 1 was made up of grass. 1/3 of part C consisted of non-native trees, of which the majority were *Ficus benjamina,* of the Moraceae family. The other 2/3 of this section was split between native and non-native shrubbery, plants, and some trees (See Table 1 for full description). Forest surrounded part of the garden, and cabins surrounded the majority of the garden.

Study design—To assess whether more birds visit native gardens than exotic gardens, I visited the three aforementioned study sites in an alternating pattern. The time frame of my project was two weeks. In the first week, I visited Los Pinos and EBMV. On day one, I started bird-watching at 7:00 A.M. at EBMV and ended at 8:30 A.M. That same day, I visited Los Pinos and bird watched there from 9:15 A.M. until 10:45 A.M. On day two, I started bird-watching at 7:00 A.M. at Los Pinos and ended at 8:30 A.M. Then, in the same day, I visited EBMV and bird-watched there from 9:15 A.M. until 10:45 A.M. I repeated this alternative schedule two times. So, I visited each garden four times that week. The second week I followed the same procedure, but with El Bosque and EBMV2. EBMV2 was the same garden as EBMV, but was referred to EBMV2 during the second week of sampling. Also, on day five, EBMV2 was not sampled.

Birds were identified, while walking around the garden in a repetitive fashion. I found a route in each garden that covered the entire area, and walked that route continually. In order to find the similarities between the different gardens, I used the Sorensen Similarity Index.

RESULTS

During my project, 21 species of birds were seen in EBMV, 23 in El Bosque, 20 Los Pinos, and 16 were seen during the 2nd week in EBMV2 (Table 1). According to Table 2, of these species the most amount of birds were shared between El Bosque and Los Pinos, and the least amount were shared between Los Pinos and EBMV2 and El Bosque and EBMV2. Note that one less day of sampling was done for EBMV2 than all the other gardens.

TABLE 1. *Representation of the number of days each species was seen in the different gardens in Monteverde, July, 2010 and the preferred habitats of each species. Obs represents the total number of days the species were seen in all.*

Species	EBMV	El Bosque	Los Pinos	EBMV2	Obs	Perferred Habitat
Bananaquit				1	1	Disturbed areas
Band-tailed Pigeon		1			1	Disturbed areas
Black Guan	1				1	Forest
Blue-crowned Motmot	1	1			2	Forest and open woodlands
Blue-gray Tanager			1		1	Disturbed areas
Blue-tailed Hummingbird		1			1	Forest and open woodlands
Brown Jay	1	1			2	Forest and open woodlands
Buff-throated Saltator			1		1	Disturbed areas
Clay-colored Robin	1	1	2		4	Disturbed areas
Common Bush-Tanager	3		1	2	6	Forest and open woodlands
Dark Pewee			1		1	Forest edge
Coppery-headed Emerald				1	1	Forest
Emerald Toucanet	2				2	Forest Edge
Yellowish Flycatcher			1		1	Forest edge
Golden-browed Chlorophonia	1				1	Forest edge
Gray-breasted Wood-Wren	1	2	1	2	6	Understory
Gray-fronted Dove				1	1	Understory
Great Kiskadee	1	1	1		3	Disturbed areas
Great-tailed Grackle		4	1		5	Disturbed areas
Green Hermit	1				1	Understory and forest edge
Green Violet-ear	1			1	2	Forest edge
House Wren	3	1	4	2	10	Disturbed areas
Masked Tytira	1	2			3	Forest and open woodlands
Mountain Elaenia	2	1	1	2	6	Forest and open woodlands
Mountain Robin	2	2	1	1	6	Forest and open woodlands
Plain Wren		1	1		2	Disturbed areas
Purple-throated Mountain-Gem	3			1	4	Forest edge
Rufous-collared Sparrow	3	1	1	2	7	Disturbed areas
Rufous-tailed Hummingbird		1	3		4	Disturbed areas
Scarlet-thighed Dacnis	1			2	3	Forest and open woodlands
Short-billed Pigeon				1	1	Forest edge
Slaty-backed Nightingale-Thrush		1			1	Understory
Steely-vented Hummingbird		4			4	Disturbebd areas
Stripe-tailed Hummingbird		1		2	3	Forest edge
Sulphur-bellied Flycatcher		1			1	Disturbed areas
Scintillant Hummingbird		1			1	Forest and open woodlands
Tropical Kingbird			1		1	Disturbed areas
Violet Sabrewing	1				1	Understory and forest edge
White-eared Ground-Sparrow	1		2		3	Forest and open woodlands
White-naped Brush-finch				1	1	Disturbed areas
White-throated Robin		1			1	Disturbed areas
White-vented Euphonia		1	1		2	Forest and open woodlands
Yellow-faced Grassquit	3	1	1	1	6	Disturbed areas
Yellow-throated Euphonia			1		1	Forest and open woodlands
Number of total species	21	23	20	16		

Table 2. *Description of preferred habitats. Categories are arranged from least to most disturbed area.*

Category	Description of preferred habitat
Forest	Mature forest
Understory	Ground or lower level of mature forest
Understory and forest edge	Both ground level and forest edge of mature forest
Forest edge	Edge of forest
Forest and open woodlands	Mature forest/ forest edge and clearings
Disturbed area	Exclusively human disturbed areas like plantations, savannas, roadsides, and gardens

TABLE 3. *Sorensen Similarity Index between three different gardens in the Monteverde Area, July 2010. The numbers left of the diagonal row of X's are the results of the Index. The numbers to the right of the X's represent the number of species of birds that the corresponding pairs of gardens have in common.*

	EBMV	Los Pinos	El Bosque	EBMV2
EBMV	X	9	10	10
Los Pinos	0.43902	X	12	7
El Bosque	0.45455	0.55814	X	7
EBMV2	0.54054	0.38889	0.35897	X

Of the species that were shared between the EBMV gardens there were forest edge species and forest and open woodlands species. So, there were some species on either side of the line, which separated more disturbed areas from non-disturbed areas (Fig. 2). In the graph comparing both EBMV gardens and El Bosque, we see forest edge species again, as well as those species to the right of the line, in disturbed areas (Fig. 2). However, in comparing the EBMV gardens and the Los Pinos garden, we only see forest and open woodland species. Finally, the majority of species that exist in both El Bosque and Los Pinos preferred habitats that were categorized as more disturbed areas (Fig. 2). When comparing the species shared in all of the gardens, most were disturbed area species, some were forest and open woodlands species and only one of nine, the Gray-breasted Wood-Wren, lied to the left of the graph as an understory species (Table 1, Fig. 2).

In analyzing which species were only seen in one garden during this period, it was found that all species lied to the left of the line in the graph (Fig. 3). In EBMV2 most species were in non-disturbed areas, with the exception of two that preferred disturbed areas, the Bananquit and the White-naped Brush-finch (Table 1, Fig. 3). In El Bosque, there was a mix of species to the right and left of the line. However, most lied to the right, in more disturbed areas (Fig. 3). In Los Pinos, most lied to the right of the line (Fig. 3). Note that the species on the left side of the graph for El Bosque was an understory species, and the species on the left side of the graph for Los Pinos was a forest edge species (Fig 3). It is important to see the difference because in this study we are denoting forest edge as a less specialized habitat than the understory of mature forest.

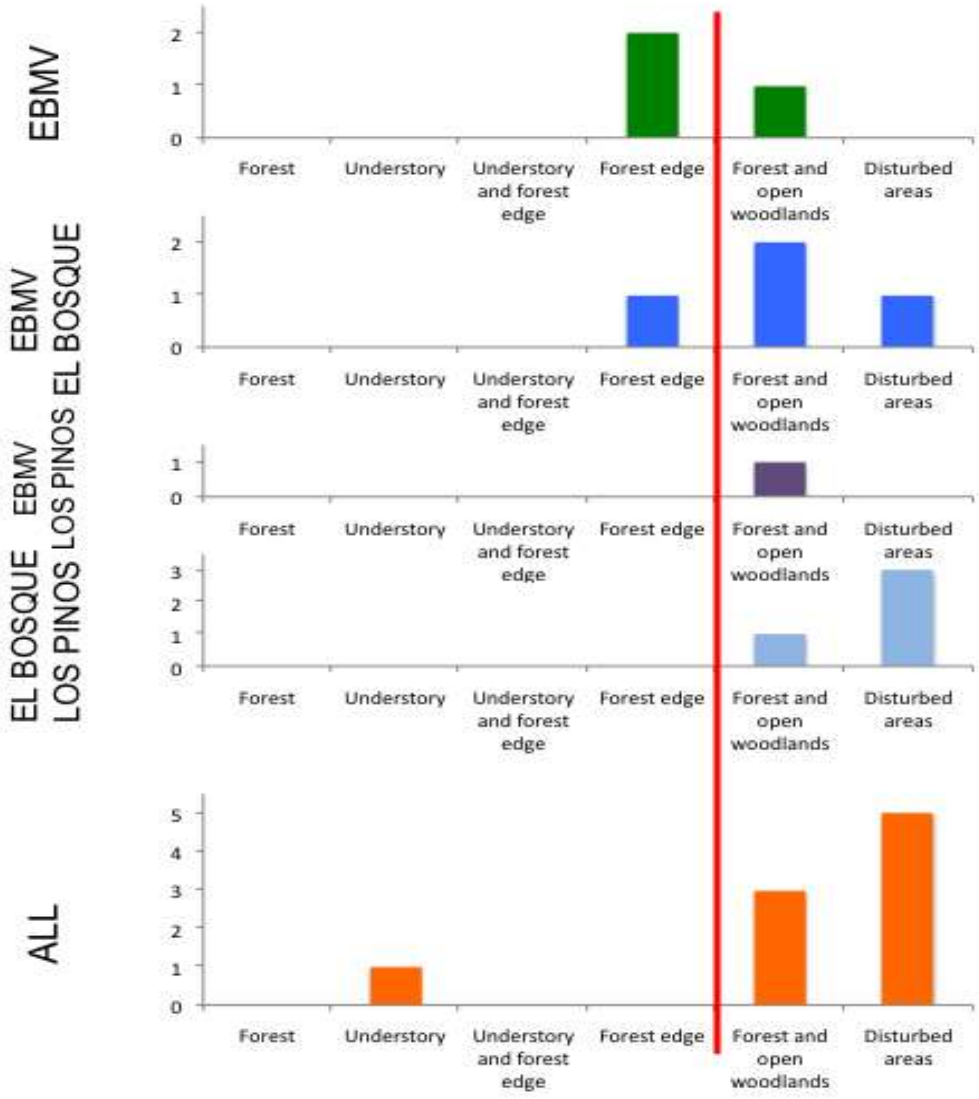

FIGURE 2. This graph shows the preferred habitats of the birds that are shared between gardens of Monteverde, July 2010. These six categories are described in Table 2. Note that, as the categories move from left to right, the preferred habitats become less specialized and more disturbed as a result of human influence. The red line in this figure represents a division between more disturbed habitats and less disturbed habitats.

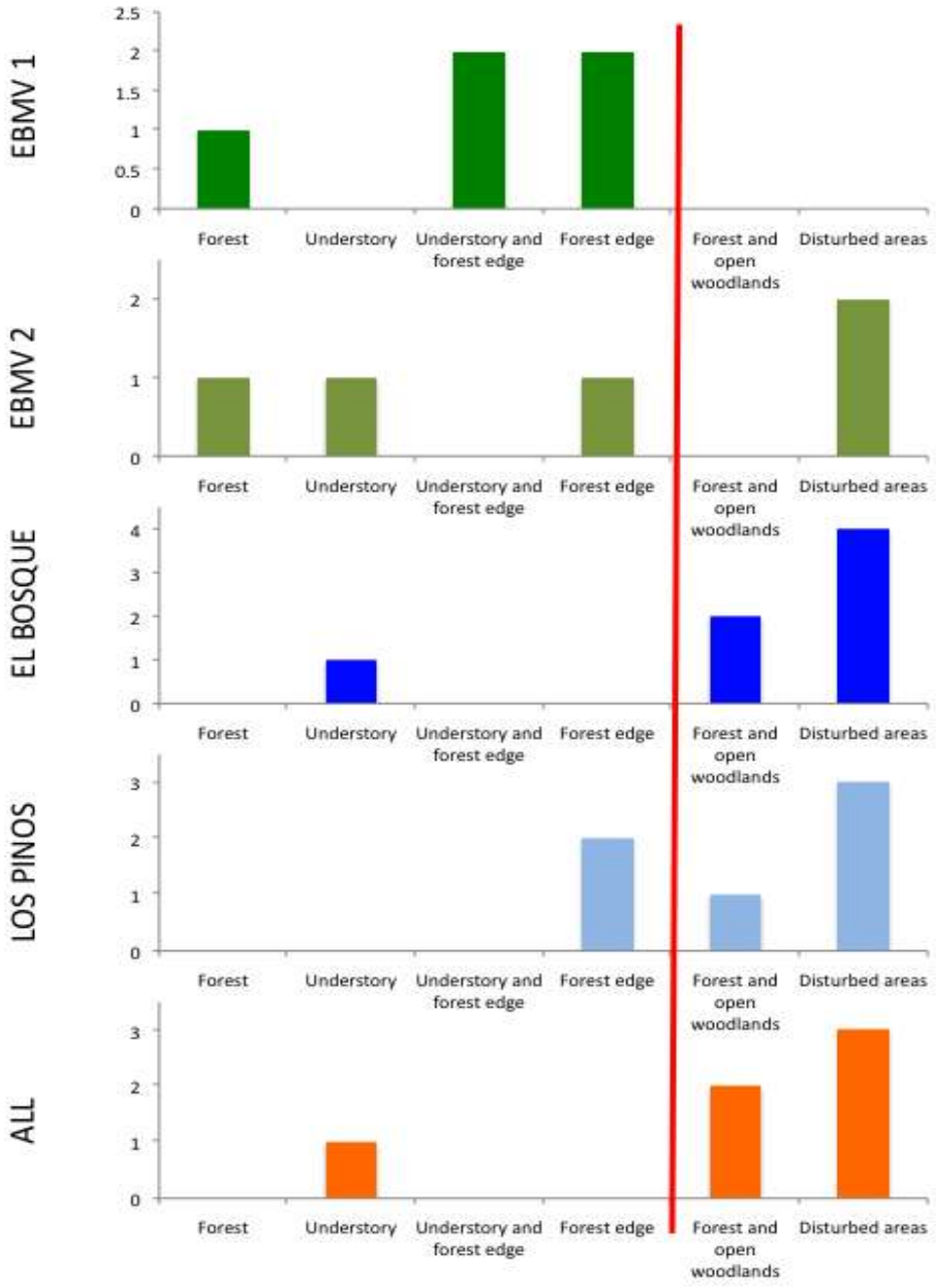

FIGURE 3. This figure shows the preferred habitats of the birds that were only seen in one place. This also shows the preferred habitats of the birds seen in EBMV, El Bosque, and Los Pinos. Note that here, EBMV and EBMV2 are considered the same location. Also, as the categories move from left to right, the preferred habitats become less specialized and more disturbed as a result of human influence. The red line in this figure represents a division between more disturbed habitats (on the right) and less disturbed habitats (on the left).

DISCUSSION

From the fact that the total number of species found in each of the gardens are very similar, it can be concluded that there is little difference in the number of bird species found in native gardens, exotic gardens, and mixed gardens. However, my findings that the most number of birds were shared between El Bosque and Los Pinos, and the least number were shared between Los Pinos and EBMV2 and El Bosque and EBMV2 suggest that there could be a trend in the type of species that visit each garden. After categorizing the birds into groups based on the habitats they prefer, trends become evident (Flanders *et al.* 2006).

When analyzing the data on which birds are shared between gardens and which habitats they prefer, we see a strong trend. We see that birds that can live in disturbed areas are found in every garden. This may be because they are well adapted to live in many different kinds of habitats, like gardens, forest, open woodlands, and plantations (Stiles & Skutch 1989). In contrast, birds that are more particular about the habitats they live in are absent in the graph showing the birds shared between all three garden sites, with the exception of one species (Fig. 3). Birds that are more specialized in the habitats they prefer, like forest edge species, are seen in the graph comparing the two EBMV gardens and the EBMV gardens and El Bosque (Fig. 2). However, forest species are absent in the graphs comparing EBMV with Los Pinnos and El Bosque with Los Pinos. This supports the idea that the more native-dominated the garden, the more likely it is that you will see a bird that prefers a more specialized habitat.

This idea is further supported by the figures showing the preferred habitats of the birds that are unique to each of the gardens. In the native garden, a lot of species to the left of the line were seen (Fig. 3). There were also species to the right of the line in the native garden, which is not important because as aforementioned, those disturbed area species are well adapted for living in many different habitats (Fig. 3). It is significant, however, that in the exotic garden, there were mostly species that are found in disturbed areas (Fig. 3). In the mixed garden, there were both species that were more specialized in their habitat selection and species that preferred disturbed habitat (Fig. 3).

Native gardens, and in some cases, mixed gardens may be better able to support these more specialized species because they harbor more insects (Tallamy 2009). Again, this is because most horticulturalists choose pest-free plants so that their plants avoid herbivory. Also, insects have to develop and adapt to the chemical defenses of plants (Reichard & White 2001). So, there needs to be an evolutionary history between the plant and the insects, which is not present with exotic plants (Tallamy 2009).

Also, many foods in Costa Rica are available in greater abundance and variety year-round, so some species become specialized to certain fruits or to sucking nectar from certain flowers (Stiles & Skutch 1989). For example, because of their beaks, specialized hummingbirds need a certain curvature to the flowers they feed on (Stiles & Skutch 1989). This requires an evolutionary history between the birds and the flower, something that birds clearly lack with exotic plants (Stiles 1981). In contrast, less specialized birds, that can live in disturbed areas well, like the Bananaquit for example, can just pierce the flower and suck the nectar (Stiles & Skutch 1989).

There were some limits to the sampling done in this experiment. I was walking

around the garden; I may not have been able to see all the birds, especially if they were behind me, or at the opposite side of the garden as me. Also, physical structure of the habitat has been thought to be an important determinant of bird distribution (Rotenberry & Wiens, 1980). Since there were differences in the sizes and structures of the gardens, this might have played a roll in what species of birds visited them. It is believed that vertical vegetation is an important determinant of the species present, and that the number of niches for birds increases with vegetative diversity (Block 1993). So the fact that there were different trees, with different heights and composition, and a different concentration of plants in each of the gardens, could have affected the number of niches available and therefore how many birds visited them.

Based on this experiment, though, I believe that native plants make a garden better equipped to support birds that prefer more specialized habitats. Since disturbed area species do not seem to mind what kind of gardens they are visiting, we should plant with an aim to conserve more particular species. In this sense, I believe that exotic plants cannot contribute to a functional ecosystem in the same way that native plants will.

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